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Abstract

CONTAINMENT AND ENGINEERED SAFETY OF NUCLEAR POWER PLANTS

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This paper reviews the safety features utilized in power producing reactors in the United States in operation or under design. Where available, pertinent operating experience is presented for some engineered safety features. In addition, new concepts now being proposed to meet more exacting siting requirements are discussed. This paper does not cover research, experimental, or propulsion reactors.

In essentially all U.S. power reactor designs the fuel is in solid form, usually a high density, high melting point ceramic material encased in a high integrity cladding which resists coolant corrosion and retains all fission products. The coolant system is generally a closed system or one which can be closed to provide a high-integrity closed coolant system. The reactor and the potentially radioactive portions of the primary coolant system are surrounded by massive concrete shielding. In addition, in all cases there is some form of confinement or containment for any material which might escape from the primary coolant system and its shielding.

Fission products can escape into the containment only as a result of some event which provides conditions leading to release of the fission products from the fuel (high temperature) and rupture of the cladding and primary coolant system. In addition, there are possibilities of fuel handling accidents

which are considered separately. Two types of events are generally considered: 1) a nuclear excursion of sufficient magnitude to rupture the cladding and the primary coolant system, and 2) rupture of the primary coolant system leading to loss of coolant and melting of the uncooled reactor core. Either of these types of accidents is considered to be most unlikely. The paper presents considerations regarding these types of accidents as well as fuel handling accidents for various reactors and provides a summary of the inherent features (temperature coefficients, Doppler effects, etc.) and the engineered features (control systems, emergency cooling systems, etc.) utilized in these reactors.

The systems utilized to limit the consequences of the escape of fission products, however unlikely, involve confinement or containment of any material released by various types of sealed cells, steel or concrete containment structures, or low-leakage buildings. There may be two such barriers. Provisions may be made to limit or reduce the volume contained (or the pressure) by means of vapor suppression, pressure relief, sprays, etc. In addition, various types of filtration and spray systems may be utilized to reduce the concentration of radioactive materials which may leak from the containment. Various methods of further reducing containment leakage including pumpback from a secondary barrier may be used. The containment system must also be protected against missiles and must be tested (and retested periodically) to insure leak tightness. These features are presented and discussed for the major types of containment.